

BLUEPRINT

Q and A on COOL ROOFS

A Special
Blueprint
on the
new
2005

Cool Roof
Requirements



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ISSUE:

New Climate Zone
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Q1. What buildings and roofing projects are subject to the cool roof requirements of the Title 24 2005 Building Energy Efficiency Standards?

A. The 2005 Standards' cool roof requirements apply to roofs on conditioned (heated or cooled) nonresidential buildings that have low-sloped roofs (2:12 or less). The requirements apply to roofs on newly constructed buildings and to most reroofs on existing buildings. A list of building types to which the cool roof requirements apply and a list of exempt building types are included at the end of these questions and answers on page 9 and 10.

NOTE that the 2005 Title 24 Energy Standards are not making building owners replace or recover existing roofs that are not in need of reroofing.

Q2. What qualifies a roof to be a cool roof under the 2005 California Building Energy Efficiency Standards (also called the California Energy Code)?

A. To be considered a cool roof in California under the 2005 Standards, a roof must:

- be tested and rated through the Cool Roof Rating Council (CRRC); and
- be labeled for its initial reflectance and initial emittance as determined in the CRRC tests and be labeled that the product meets Title 24, Section 118(i); and
- achieve at least a 0.75 initial emittance and 0.70 initial reflectance or, if the initial emittance is less than 0.75, have an initial reflectance of at least $[0.70 + \{0.34 \times (0.75 - \text{initial emittance})\}]$;^{*}
and
- if applied as a liquid coating in the field, be applied at a minimum dry mil thickness of 20 mils* across the entire roof surface and meet performance requirements listed in the table shown immediately below:

TABLE 118-C**

Physical Property	ASTM*** Test Procedure	Requirement
Initial percent elongation (break)	D 2370	Minimum 60% 0 °F (-18 °C) Minimum 200% 73 °F (23 °C)
Initial tensile strength (maximum stress)	D 2370	Minimum 100 psi (1.38 Mpa) 73 °F (23 °C) Minimum 200 psi (2.76 Mpa) 0 °F (-18 °C)
Final percent elongation (break) after accelerated weathering 1000 h	D 2370	Minimum 40% 0 °F (-18 °C) Minimum 100% 73 °F (23 °C)
Permeance	D 1653	Maximum 50 perms
Accelerated weathering 1000 h	D 4798	No cracking or checking Any cracking or checking visible to the eye fails the test procedure

NOTE: Aluminum-pigmented asphalt roof coatings and cement-based roof coatings are not required to meet this table. The former must meet ASTM D2824, D6848, and D3805 and the latter must meet greater dry mil thicknesses (depending on the substrate) and meet ASTM D822. Details are found in Standards Section 118(i)3.

^{*}Being an ENERGY STAR roof does not automatically qualify a roofing material to be a cool roof in California because ENERGY STAR has different criteria.

^{**} The Energy Commission is currently conducting a rulemaking that may result in changes to the minimum dry mil thickness and to Table 118-C. See: www.energy.ca.gov/title24/roofcoatings/

^{***} American Society for Testing and Materials

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The new 2005 California Energy Efficiency Standards are now in effect as of October 1, 2005

Q³. I understand that building departments are responsible for enforcing the cool roof requirements. Who is educating building departments about these requirements?

A. Several entities are educating building departments. California's electric and gas utilities hold classes at their training centers and several private consultants are offering training to building departments. The Energy Commission publishes the Nonresidential Compliance Manual with detailed information about the Standards and this Blueprint, which is distributed electronically to all building departments and other subscribers.

The Energy Commission also maintains a Title 24 Hotline (800-772-3300 or 916-654-5106 or title24@energy.state.ca.us) and attends local and statewide meetings of building officials to provide information and training about the Energy Standards. We will also provide or coordinate onsite training upon request.

The Energy Commission is aware that a number of for-profit roofing suppliers and industry groups are holding training for the public and for public officials. The Energy Commission asks that trainers provide their training materials to the Energy Commission for review and provide the dates and locations of the scheduled training. If staff is available, the Energy Commission offers to sit in on training sessions to help assure accuracy and answer questions.

Q⁴. What determines whether a roofing job must comply with the 2005 Energy Standards or can comply with the 2001 Energy Standards?

A. The effective date of the 2005 Energy Efficiency Standards was October 1, 2005. The date that the building permit application is submitted to the building department is the determining factor. If the building permit application for a newly constructed building, a building addition, or a reroof is submitted on or after October 1, 2005, the project must comply with the 2005 Energy Standards requirements.

Q⁵. What if a building department does not require a building permit for a reroof?

A. First, note that the Energy Standards do not apply to small reroofs; they apply only if the job involves over half the roof or more than 2,000 square feet (whichever is less). The Standards must be met if the local building department requires a building permit for reroofs that are larger than those sizes.

Note that often local jurisdictions adopt the permit requirements of the California Building Code (CBC) without change. If the jurisdiction has adopted the California Building Code, Part 2, Volume 1, Section 106 without changes that exempt roofing, that jurisdiction requires a building permit for reroofs. In that case the Energy Standards apply and the roofing contractor must comply.

If the jurisdiction has not adopted the CBC permit requirements or has adopted changes to them that exempt specific reroofs, the cool roof requirements don't apply for those reroofs. Note that the cool roof requirements still may be considered a "standard of care" in a court proceeding.

Photos for this issue are from the Energy Commission online training series, and the courtesy of Dan Varvats and DNG

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Q6. What if a roof material is not tested and rated through the Cool Roof Rating Council (CRRC)? Can it still be installed in California?

A. In some cases, yes. Without a CRRC rating, a roof material is assigned default values for reflectance and emittance that are substantially lower than the cool roof requirements stated in the answer to Question 2. A newly constructed building with other highly energy-efficient features or a reroofing job that is part of a project that makes other energy efficiency upgrades to the building will be able to comply through the performance approach or the overall envelope approach.

Note: Even if a roof has high reflectance and high emittance, if it does not have a CRRC rating, it cannot claim a reflectance or emittance higher than the default values for showing compliance with the Standards.

Cool Roof Rating Council

www.coolroofs.org

Rated Product Directory

www.coolroofs.org/ratedproductsdirectory.html/

Q7. I am a roofer and am not very familiar with the Energy Standards. How do the Energy Standards work?

A. In general terms, the Energy Standards set an energy budget for newly constructed buildings, and additions and alterations to existing buildings for how much energy they can use. The budget is given in energy (kBtu, or thousand Btu) per square foot per year. The Standards address a number of energy efficiency measures that impact energy used for lighting, water heating and heating, and air conditioning, including the energy impact of the building envelope (windows, doors, skylights, wall/floor/ceiling assemblies, attics, and roofs).

A roofer must submit specific documents to the building permitting agency to show how they are complying with the energy budget, and they must

build accordingly. While the Energy Commission has designated some energy measures as mandatory for newly constructed buildings, additions, or alterations, roofers also have several options for complying with the budget, using prescriptive approaches or the performance approach.

For nonresidential buildings, there are two ways to comply with the prescriptive cool roof requirements. The first is the building envelope component approach, in which the cool roof requirements, stated in question two above, must be met with no variation.

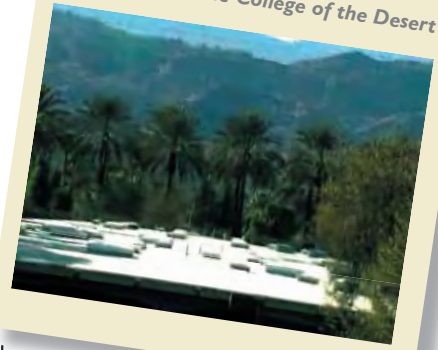
This approach is the simplest, but allows no flexibility. The second prescription approach is the overall building envelope approach, which provides equations that allow partial credit for roofing products that have CRRC ratings but don't meet the minimum 0.70 and 0.75 reflectance and emittance levels. This approach allows trade-offs among components of the building envelope and applies to newly constructed buildings, additions or reroofing projects that also involve insulation, window replacement, or other envelope upgrades (under the same building permit).

Not putting on a cool roof has to be compensated by increases in other building envelope components that make up for the increased solar heat gain resulting from not having a cool roof. This approach is somewhat more complicated than the building envelope component approach but allows some flexibility.

The other way to comply with the Standards is to use the performance approach. Under this approach, all of the characteristics that impact the energy consumption of the building, addition, or alteration are modeled by computer using Energy Commission-approved compliance software.

The energy budget for a proposed building is determined by modeling the building, but assuming that all the mandatory and prescriptive measures for the proposed building type and its climate zone are installed. The modeled budget-setting version of the building is referred to as the "standard design." Then the proposed building is modeled using its energy-impacting measures; this version is referred to as the "proposed design."

Cool Roofs at the College of the Desert



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If the energy use of the proposed design is less than or equal to the energy use of the standard design (that is, the energy budget), the proposed building complies; if not, it's back to the drawing board to add more efficiency measures to the proposed building. Many variations of energy efficiency measures can be designed into the proposed building, as long as the computer modeling shows that the building will use no more energy than the energy budget.

The energy budget (standard design) for nonresidential buildings with low-sloped roofs assumes that the building has a cool roof. When modeling the proposed design, the actual CRRC ratings for the planned roofing product are used to help show compliance with the energy budget. "Partial" energy credit is allowed for CRRC-rated roof products that don't fully meet the minimum 0.70 reflectance and 0.75 emittance levels.

The performance approach is the most complicated compliance approach but allows the most flexibility. If you need assistance with the performance approach, energy consultants are available who have expertise in running the software. Many of them

belong to the California Association of Building Energy Consultants (CABEC), www.cabec.org, which lists its members with contact information.

Q8. What are the cool roof requirements for reroofing projects?

A. For reroofing of nonresidential, low-sloped roofs over conditioned space, if more than 50 percent of the roof or more than 20 squares (2,000 square feet) — whichever is less — is being replaced, recovered, or recoated, you must install a qualifying cool roof OR you must provide calculations that show that the heat gain into the building through the new roof will be less than or equal to the heat gain through a cool roof. Through these calculations, you can get credit for lowering the heat gain by installing extra insulation. When considering a garden roof in reroofing, these calculations could also account for the extra insulative value of soil or for other energy-saving characteristics or components of the roof assembly.

Steve Easley interviews Energy Specialist Elaine Hebert about the new "Cool Roof" prescriptive requirements in the 2005 Energy Efficiency Standards. The interview is part of a new training video available soon at www.energy.ca.gov/title24/coolroofs



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Note: If you make other changes that affect the building's energy use under the same permit as the reroofing, you could consider those changes together in complying with the prescriptive overall envelope approach or the performance approach (see Question 3 for more on prescriptive and performance approaches).

Q⁹. Are there any types of nonresidential reroofs that are not required to comply with the cool roof requirements?

A. Yes. Any roof over unconditioned space is exempt. (A cool roof will, however, increase the comfort level of persons working in unconditioned warehouses in many of California's climate zones.) Also, any reroof under 20 squares (2,000 square feet) or 50 percent of the roof — whichever is less — does not have to comply with the cool roof requirements. For reroofs that are larger than this, there is one special case. Rock or gravel roofs that meet specific conditions, that don't have to comply. Rock and gravel roof recoverings are allowed by the CBC do not have to meet the cool roof requirements if all of the following conditions are true:

1. The existing roof has a rock or gravel surface, and
2. The new roof has a rock or gravel surface, and
3. There is no removal of existing layers of roof coverings of more than fifty percent of the roof or more than 2,000 square feet of roof, whichever is less; and
4. There is no recoating with a liquid applied coating; and
5. There is no installation of a recover board, rigid insulation or other rigid, smooth substrate to separate and protect the new roof recovering from the existing roof.

Q¹⁰. I understand that cool roof requirements apply to nonresidential buildings with low-sloped roofs, but if cool roofs are installed on other types of buildings that are covered by the Standards, do they receive credit toward meeting the energy budget of those buildings?

A. Yes. Compliance credit (credit toward meeting the energy budget) is available for nonresidential buildings with high-sloped roofs, for high-rise (four stories or

more) residential buildings, and for hotels and motels. through either the performance approach or the overall envelope approach. Other buildings with CRRC-rated roofs can get credit (even if they don't fully meet the minimum 0.75 initial thermal emittance and 0.70 initial solar reflectance levels in the answer to Question 2)

For low-rise residential buildings, compliance credit is also available through the performance approach for CRRC-rated roofs that meet the initial thermal emittance and initial solar reflectance levels. Compliance credit is available for concrete and clay tile roofs that are CRRC-rated to have initial solar reflectances of 0.40 or greater.

Q¹¹. What is emittance?

A. Emittance is a measure of how well a surface or material gives off (or emits) the energy it absorbs. No roof surface is a perfect reflector; all roof surfaces reflect some of the sun's energy and absorb some of the sun's energy as heat. The longer that heat is held, the more opportunity it has to travel downward through all the layers of roof material and into the conditioned space. That heat can increase the air conditioning load for the building and/or make the occupied space less comfortable. High-emitting roof surfaces give off absorbed heat relatively quickly through the path of least resistance — upward (and out of the building). Emittance is given a number between 0 and 1, where 1 would be a theoretically perfect emitter. A rating of 0.75 is a relative high rating and desirable to keep heat out of air conditioned space.

NOTE: Keeping the air conditioning load down in California is critical for meeting the state's electricity demand. Air conditioning is electricity-intensive. On a hot summer day, when more air conditioning is running to keep people cool, electricity supplies may not be available to meet demand. Recall that in 2000 and 2001, California utilities had to resort to rolling blackouts to keep the electricity grid intact.

Q¹². What about garden roofs (roofs whose top surfaces are composed of soil and plants)? They are not cool roofs by their reflectance properties, so will they be allowed under the 2005 Standards?

A. Yes. For newly constructed buildings, use the performance (computer modeling) approach to show that

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the proposed building with a garden roof will meet the allowed energy budget. For reroofing, provide heat gain calculations that show that the garden roof (with possible extra insulation added to the roof assembly) will allow no more heat gain into the building than a prescriptive cool roof on the same building.

Q13. What about roofs with a deck or patio meant for foot traffic, where non-cool surfaces, such as concrete pavers, are the roof surface over some percentage of the total roof area?

A. For newly constructed buildings, use the performance (computer modeling) method to show that the proposed building with a patio or deck roof will meet the allowed energy budget. For reroofing, provide heat gain calculations that show that the roof will allow no more heat gain than a prescriptive cool roof would allow. Again, meeting these heat gain requirements is likely to require an added measure such as roof insulation.

Q14. What about solar photovoltaic (PV) panels installed on roofs?

A. Consider the different configurations of solar panels. Often solar panels, for either heating water or generating electricity, are mounted on racks above the roof surface or occasionally resting on the roof surface. The panels could be removed and the roof would still be there. In these cases, the cool roof regulations apply to the roof surface under the solar system.

On the other hand, there are some solar electric photovoltaic (PV) systems on the market that are embedded in or integrated into the roof, becoming the roof surface. With the dark color of solar cells and their function of absorbing solar energy to create electricity, they are not a cool roof material.

In this case the answer is the same as for questions 12 and 13. When reroofing with roof-integrated solar, you must take some measures, such as adding insulation, to insure that heat gain into the conditioned building is no

greater with the solar roof than it would be with a cool roof.

Q15. Can the electricity from photovoltaic (PV) solar electric systems be used as a trade-off in meeting a building's energy budget?

A. No. The Energy Commission does not allow trade-offs for PV-generated electricity that would reduce the minimum energy efficiency requirements of the Standards or count toward meeting the energy budget. For the 2008 Standards, the Energy Commission is considering a "Tier II" voluntary Standard that would set a benchmark for the combination of PV and higher-than-Standards-levels of energy efficiency.

Q16. In evaluating the energy savings and cost effectiveness of cool roofs, did the Energy Commission consider the degradation in reflectance over time?

A. Yes. The Energy Commission assumed the reflectance declined to 0.55.

Q17. Do the Energy Standards use the reflectance of roofing products after three years of weather exposure for compliance purposes?

A. No, not in the 2005 Energy Standards. For the 2008 Energy Standards the Energy Commission will consider using CRRC certified three-year aged reflectances when they become available and have been evaluated.

Q18. What are the requirements for adding roof insulation when you are reroofing nonresidential buildings?

A. It depends:

- (i) If you are installing a cool roof, you don't need to deal with insulation at all unless you alter existing insulation during the course of the reroof job [that is, you remove or replace some or all of the insulation - see item (iii) below if you alter the insulation]. If you are reroofing with a cool roof and there is absolutely



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no insulation anywhere in the roof assembly, you are not required to install any.

(ii) If you are not installing a cool roof on a building that requires a cool roof under the prescriptive approach, you must comply with the Energy Standards some other way. Adding insulation will probably be the most common and easiest way. To calculate how much insulation is needed in this case, you must use the heat gain equations in Standards Section 143(b) or the performance method. Efforts are underway under the Energy Commission's supervision to develop a spreadsheet tool to make this calculation easier.

(iii) If you are reroofing and you alter some existing insulation — that is, you remove or replace it — you must not decrease the R-value of that existing insulation. You must re-install at least the same insulation level.

(iv) If you are reroofing a building that requires a cool roof under the prescriptive approach and there is no insulation anywhere in the roof assembly, and the building owner/manager wants to add some, you can put in any amount of insulation. You do not have to meet the prescriptive requirement.

Q19. I am a roofer and I want to apply a cool roof coating to an existing built-up roof. Under the prescriptive method, a liquid-applied coating over an existing roof must have a minimum dry thickness of 20 mils. One manufacturer is saying that they can achieve the required 20 mils by applying one 10 dry mil layer of their base coat and one 10 dry mil layer of their top coat. The base coat does not have a minimum initial solar reflectance of 0.70, but the top coat does. Is the proposed method of combining one 10 mil layer of a liquid base coat and one 10 mil layer of a qualifying liquid topcoat an approved cool roof?

A. Yes, as long as the two coatings have been tested together (as the manufacturer intends for them to be installed in the field) through the Cool Roof Rating Council and this combination meets the reflectance and emittance requirements.

Q20. What are the cool roof requirements for schools?

A. Schools must meet the requirements of the Standards, including those for cool roofs. Public schools are granted building permits by the State's Division of the State Architect (DSA) rather than by local building departments. DSA's regulations expressly require compliance with the Title 24 Building Energy Efficiency Standards. The same is true for public colleges and universities. Private schools of any grade level require compliance to be shown to the local building department.

Watch for additional questions and answers on Cool Roofs in coming issues of the Blueprint.

**California
Building Code
Uses and
Occupancies that
apply to cool
roofs
(CBC, Title 24, Part 2,
Chapter 3):**

*Note:
Qualifying
historic buildings
are exempt from
any cool roof
regulations.*

Types of buildings subject to cool roof requirements:

Group A – Assembly

Building or structure, or portion thereof, for the gathering of 50 or more persons for purposes such as civic, social or religious functions, recreation, instruction, food or drink consumption, or awaiting transportation. Examples: restaurants, arenas, churches, theaters.

Group B – Business

Building or structure, or portion thereof, for office, professional or service-type transactions; includes storage of records and accounts and restaurants with occupant load less than 50. Examples: animal hospitals, kennels, automobile showrooms, banks, barber shops, outpatient clinic and medical offices, educational occupancies above the 12th grade, fire stations, florists and nurseries, testing and research labs, print shops, radio and TV stations

Group E – Educational (through 12th grade)

Building or structure, or portion thereof, for educational purposes through 12th grade for more than 12 hours per week or 4 hours in any one day. Examples: schools, nonresidential buildings used for daycare for more than six children, residential buildings used as daycare for more than 14 persons.

Group F – Factory (low- and moderate-hazard)

Building or structure, or portion thereof, for fabricating, manufacturing, packaging, processing, etc. Examples: furniture manufacturing, bakeries, food processing plants, paper mills, printing or publishing facilities, refuse incineration, shoe factories, dry cleaning facilities.

Group H – Hazardous facilities

Building or structure, or portion thereof, that involves the manufacturing, processing, generation or storage of materials that constitute a high fire, explosion, or health hazard. Examples: manufacturing plants for explosives, blasting agents, fireworks, flammable gases; storage facilities for such products.

Group M – Mercantile (sale of merchandise)

Building or structure, or portion thereof, for the display and sale of merchandise. Examples: department stores, shopping centers, wholesale and retail stores, markets.

Group S – Storage facilities

Building or structure, or portion thereof, for storage not classified as a hazardous occupancy. Examples: storage of beer or wine in metal, glass, or ceramic containers, of cement in bags, of foods in noncombustible containers, of gypsum board, of stoves, washers, and dryers.

Group U – Utility facilities

Private garages, carports, sheds, agricultural buildings, and towers.

Types of buildings which are exempt from cool roof requirements:

Group I – Institutions

Hospitals, sanitoriums, nursing homes with nonambulatory patients with more than 5 patients; nursing homes for ambulatory patients; mental hospitals, jails, prisons; nurseries for the full-time care of at least 5 children under the age of 6.

Cool roofs are optional — not prescriptive — for the following:

- Unconditioned warehouses and other buildings
- “Process spaces” – not meant for human occupancy, held at temperatures less than 55°F or greater than 90°F
- Buildings cooled by swamp coolers/evaporative coolers
- High-rise residential buildings (4 stories and more)
- Hotels and motels
- Any roof with slope greater than 2:12

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New on the Web

Now using a special overlay for Google Earth™ it is possible to locate specific addresses on the Energy Commission's updated California Climate Zone Map. This will help in determining where boundary lines fall, and in which climate zone specific addresses are located.

To download the new Climate Zone overlay for Google Earth™ follow the directions at:

www.energy.ca.gov/maps/climate_zone_map.html

Welcome to the **California Energy Commission**

WWW.ENERGY.CA.GOV / MAPS / CLIMATE_ZONE_MAP

California Energy Maps

California Climate Zone Map

Google Earth™
California Climate Zones on Google Earth™

Download a more detailed [Climate Zone Map](#) (adobe PDF, 1 page, 3.5 megabytes)

List of climate zones areas by City, Towns and other Locations:

[CLIMATE ZONES CITY LIST AROBAT PDF](#)

[CLIMATE ZONES CITY LIST MS WORD](#)

List of climate zones areas by zipcode:

[CLIMATE ZONES BY ZIPCODE LIST AROBAT PDF](#)

[CLIMATE ZONES BY ZIPCODE LIST MS EXCEL](#)

Google Earth™ California Climate Zones on Google Earth™

Outlines of California's 16 Climate Zones have been overlaid on Google Earth™. Look at the boundary areas.

Image © 2005 MDA EarthSat

Google

Notification of Available Errata

The Energy Commission recently posted on it's website errata pages for both the 2005 Residential and Nonresidential Compliance Manuals. Each revised page is in PDF format with informational notes indicating the changes. The latest 3rd Quarterly Revision errata labeled 3Q-05 at the bottom can be downloaded from the appropriate web link:

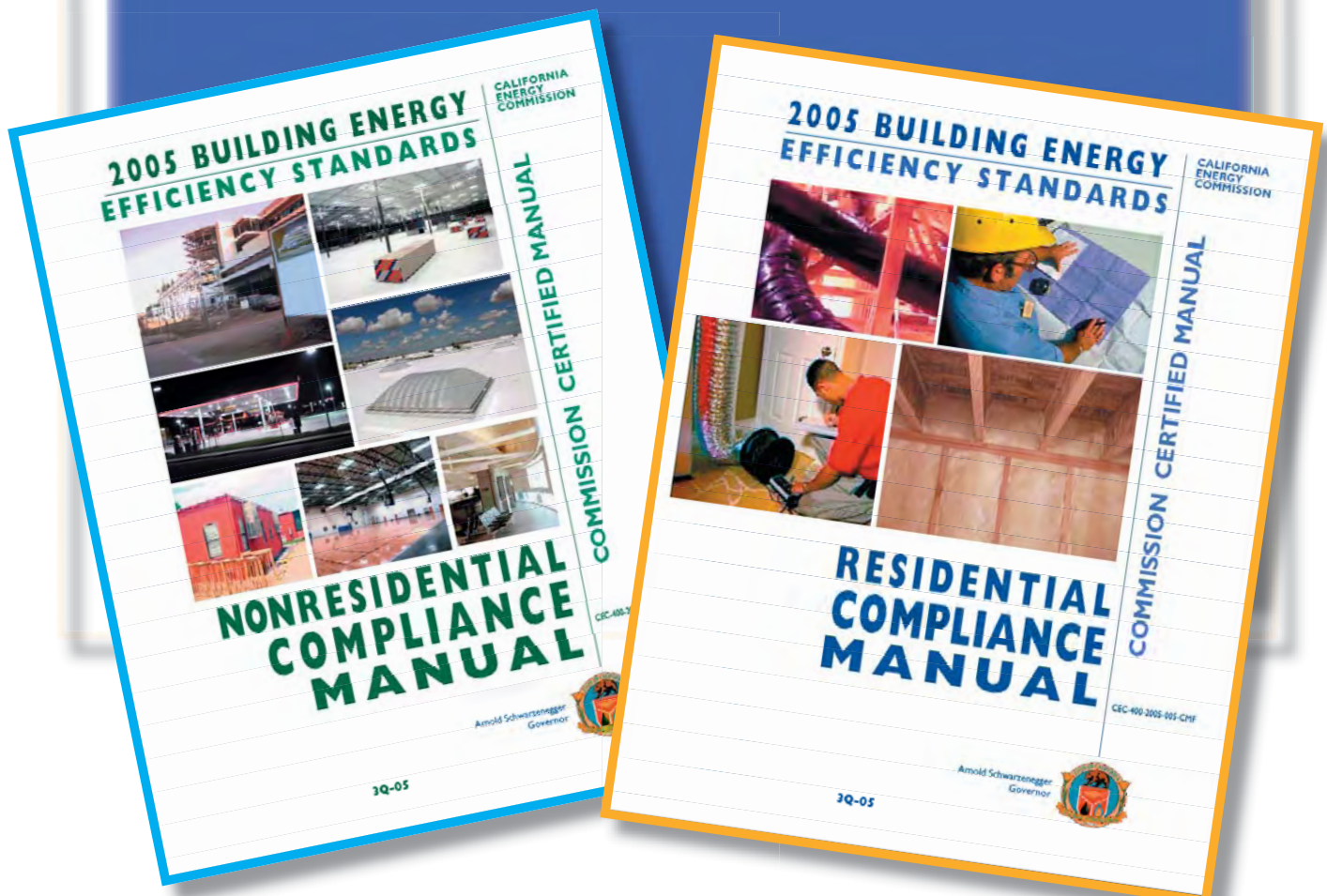
Residential

http://www.energy.ca.gov/title24/2005standards/res_manual_errata/index.html

Nonresidential

http://www.energy.ca.gov/title24/2005standards/nonres_manual_errata/index.html

A Fourth Quaterly Revision (4Q-05) will also be posted in January 2006.



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Title 24

Energy Efficiency Standards Training

Arnold Schwarzenegger
Governor

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Tony Rygg, Maziar Shirakh, Elaine Hebert,
Ram Verma, John Eash, Gary Flamm,
Nelson Peña, Rob Schlichting, Rob Hudler
and Tav Commins for their help
in creating this edition of the Blueprint.

Publication number CEC-400-2005-053

Links for training on issues relating to California Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24, Part 6) are available on the Energy Commission's website at:

<http://www.energy.ca.gov/title24/training>

For training offered by the utilities and other organizations please see the following websites:

PG&E:

<http://www.pge.com/stockton>

SoCal Gas Co.

<http://seminars.socalgas.com/int/default.asp>

San Diego Gas and Electric

<http://seminars.sdge.com/int/default.asp>

SCE:

<http://www.sce.com/RebatesandSavings/EnergyCenters/workshops.htm>

SMUD:

<http://www.smud.org/education/index.html>

CALBO TRAINING INSTITUTE

<http://www.calbo.org>

BUILDING INDUSTRY INSTITUTE (BII)

<http://www.consol.ws/bect.asp>

CABEC:

<http://www.cabec.org/cepetrainandtest.php>

Nonresidential Fenestration Certification Initiative (NFCI)

<http://nfci.ecst.csuchico.edu>

Residential Lighting Design Guide

– Best practices and lighting designs to help builders comply with California's 2005 Title 24 energy code

<http://www.cltc.ucdavis.edu/>



Need Help? CALL THE ENERGY HOTLINE @

(800) 772-3300 or (916) 654-5106